



Seasonal Changes of Length-Weight Relationships and Condition Factor of Three Fish Species from the Tanoe-Ehy Swamp Forest (Côte d'Ivoire)

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Authors' contributions

This work was carried out in collaboration among all authors. Author YAK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AIM and YJS managed the analyses of the study. Author TK managed the literature searches and supervised the research. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The Tanoe-Ehy swamp forest (TESF) is a freshwater swampy area characterized by seasonal variation of environmental parameters and fish diversity. So, the aim of this study was to analyze seasonal variations of growth parameters and condition factors of the three abundant species.

Methodology: Specimens were collected by using gill nets and fyke nets, measured and weighed. Length-weight relationship (LWR), Fulton's condition (K_F) and relative condition (K_R) factors were analyzed from Standard Length (SL) and body weight (BW).

Results: The Standard Length of *Clarias buettikoferi*, *Thysochromis ansorgii* and *Parachanna obscura* varied between 9.50 and 29.30 cm, 4.60 and 11.50 cm, 10.70 and 29.30 cm, respectively.

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The growth type of population was allometric negative for *C. buettikoferi* and *P. obscura* and isometric for *T. ansorgii*. In terms of seasonal variation, *C. buettikoferi* females and *P. obscura* specimens exhibited isometric growth in dry seasons (DS) against a negative allometric growth in flooded seasons (FS). In contrast, female and combined sex specimens of *T. ansorgii* showed positive allometric growth in DS and isometric growth type in FS. K_R varied between 0.76 and 2.02 and was significantly higher in FS than in DS, indicating a state of well-being during flooded seasons in the 3 species.

Conclusion: There was a significant relationship between length with weight and both condition factor for the three species. This study provided the first data about fish body measurements in the TESF and concluded that LWRs and condition factors of the three fish species were strongly influenced by seasonal variations in hydrological conditions.

Keywords: Swampy area; allometric; isometric; dry; flooded; seasonal variations; Tanoe.

1. INTRODUCTION

The swampy areas have large variations in hydrological conditions, which results in a significant variation in species richness and diversity [1,2]. The Tanoe-Ehy swamp forest (TESF) is a freshwater forest characterized by seasonal variation of environmental parameters ranging from a few centimeters to several meters deep [3]. This swamp forest is home to permanent fish species capable of withstanding extreme environmental conditions such as acidity and hypoxia during dry seasons while temporary species are observed during flooded periods [3].

The three species *Clarias buettikoferi* Steindachner, 1894, *Thysochromis ansorgii* (Boulenger, 1901) et *Parachanna obscura* (Günther, 1861) were the most abundant permanent species in the TESF and represent an important protein source for local populations [4]. They are known as species able to support stressful conditions [5,6]. For example, the study of reproductive strategies of *C. buettikoferi* and *T. ansorgii* in the TESF showed that the spawning periods were observed in rainy periods when the environmental conditions are favorable [7,8]. In addition, fecundity was higher in rainy periods than in dry season in *C. buettikoferi* [8]. Both species have a pelagic diet in rainy periods and benthic diet in dry periods [9,10]. Therefore, it is likely that these species change their growth parameters according to seasons. Indeed, studies have shown that a variation in hydrological conditions has caused changes in fish growth parameters [11,12].

An aquatic animal's condition reflects recent environmental circumstances, as it fluctuates by interaction among feeding conditions, parasitic infections and physiological factors [13]. Indeed, the relationship between body length and weight

is useful for assessing the well-being of the individuals and for determining possible differences among different stocks of the same species [14]. It provides information about the growth pattern, general health, habitat conditions, life history, fish fatness and condition, as well as morphological characteristics of the fish [15,16]. Although length-weight relationship parameters exist in other ecosystems [17,18,19], data from swampy areas, influenced by high seasonal variations of hydrological conditions, are limited. Therefore, the aim of this study was to estimate LWR and condition factors of the three fish species and consider seasonal variations of these parameters.

2. MATERIAL AND METHODS

2.1 Study Area

The Tanoe-Ehy swamp forest (TESF) is located in South-eastern Côte d'Ivoire between latitudes 5°6'N and 5°12'N and longitudes 2°54'W and 2°43'W. It is a swampy forest of a surface area of approximately 12000 ha bounded by the Tanoe River and Ehy lagoon [20] (Fig. 1). It is drained by a stream network that is generally shallow, slow flowing, leading to the formation of pools and ephemeral streams, as well as flooded areas that form when periods of heavy rainfall occur. Hydrological seasons are characterized by four periods : the first dry period (January-April), the first flooded period (May-July) ; the second dry period (August-September) and the second flooded period (October-December) [3]. The TESF mainly consist of moist, partly primary forests on predominantly sandy soil. Based on tree composition and the depth of ground water, two habitat types characterize that forest: the flooded forest and the mangroves. While the flooded forest consists of evergreen forest inundated during most times of the year, the

mangrove forests are permanently flooded and more difficult to access [21]. Canopy height can reach 30 meters and canopy cover is generally high, except the peripheral areas where there has been greater human influence [22].

2.2 Methods

2.2.1 Sampling and data analysis

Fish samples were collected monthly in four sites from the TEF swampy environments using gillnets and fyke nets. Specimens were preserved in 10% formalin, identified following [23]. Length (Standard and Total Length) was measured to the nearest 0.1 cm by using a caliper and Weight was measured using a digital balance with an accuracy of 0.1 g.

In this study, Standard Length (SL) was used in Length-weight relationship (LWR) estimation due to predation which could impact the Total Length (TL) of individuals [12,19]. TL was also used to make length comparisons with previous studies. The data from samplings were grouped into length classes of 1 cm or 2 cm interval for estimate Length-frequency distributions of the three species. Length frequency data such as mean, minimum, maximum SL was determined on seasonal and sex basis. Additionally, 95%

confidence limits of the length (cm) and weight (g) measurements were estimated.

The LWR was calculated using the expression: $BW = aSL^b$, where BW is the total body weight (g), SL the Standard Length (cm), a and b representing the intercept and the slope of the relationship. Parameters a and b of the LWR were estimated by linear regression analysis based on natural logarithms: $\ln(BW) = \ln(a) + b \ln(SL)$. The coefficient of determination r^2 was also estimated. To confirm whether b values were significantly different ($P \leq 0.05$) from the isometric value ($b=3$), the equation of [24]: $ts = (b-3)/sb$ was applied, where ts is the sample t-test value, b is the slope and sb is the standard error of the slope (b). The comparison between ts and tabled, critical values for b allowed determination statistical significance and their classification as isometric ($b=3$) or allometric (negative allometry for $b < 3$ or positive allometry for $b > 3$) [25].

Fulton's condition factor (K_F) was calculated following the equation: $K_F = 100 \times (BW/SL^3)$, where BW is the total body weight (g) and SL is the Standard length (cm) [26]. The relative condition factor (K_R) for each individual was calculated using this equation: $K_R = BW/(a \times SL^b) \times 100$, where a and b are the LWR parameters [27].

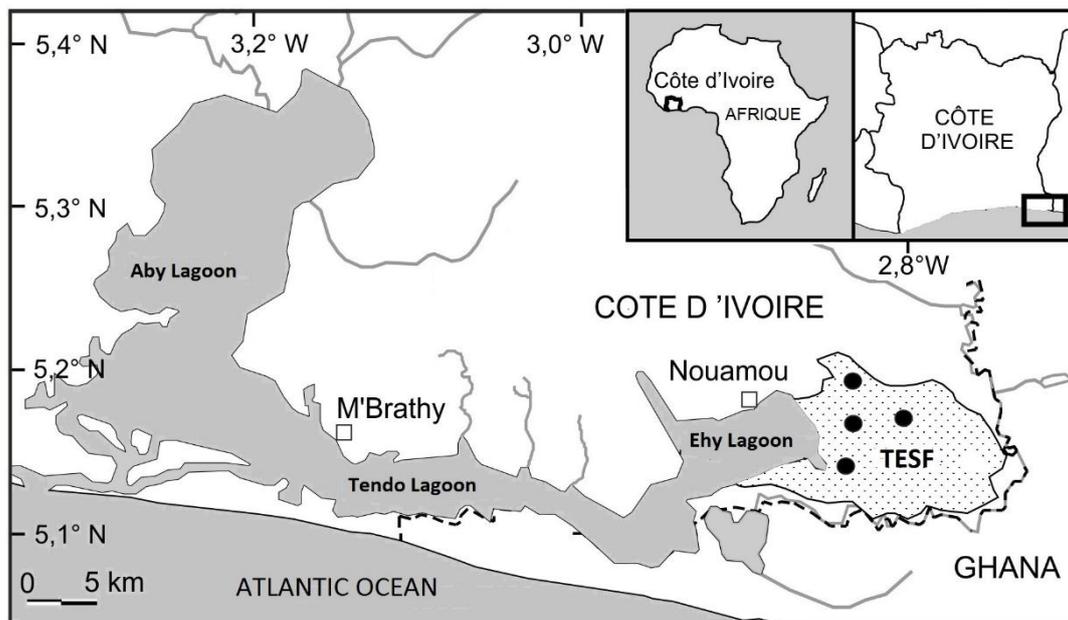


Fig. 1. Map of Tanoe-Ehy swamp forest (TESF) showing the sampling sites (South-eastern Côte d'Ivoire)

2.2.2 Statistical analyses

The data were analyzed by sex and season. The data for the dry seasons were combined into one season, as were the flooded seasons. Tests for normality of each group were conducted using the Shapiro-Wilk test where the normality assumption was met [13]. One-way ANOVA was used to compare the Length-frequency distributions, the slope “*b*”, condition factors between the seasons and sexes. In case of non-parametric statistics, the Mann-Whitney U test was used for comparisons. The Spearman rank test was used to correlate body measurements (SL and BW) with condition factors (K_F and K_R). All statistical analyses were conducted using PAST 3.1 software and were considered significant at 5% ($p < 0.05$).

3. RESULTS

3.1 Length-Frequency Distributions

Table 1 and Figure 2 illustrate the descriptive statistics and 95% confidence limit (CL) for length and weight measurements of the three fish species. The SL of *C. buettikoferi* ranged from 9.50 cm to 29.30 cm (mean±SD = 18.26±3.41) and the BW varied from 8.50 g to 205.00 g (mean±SD = 72.71±36.74). The length

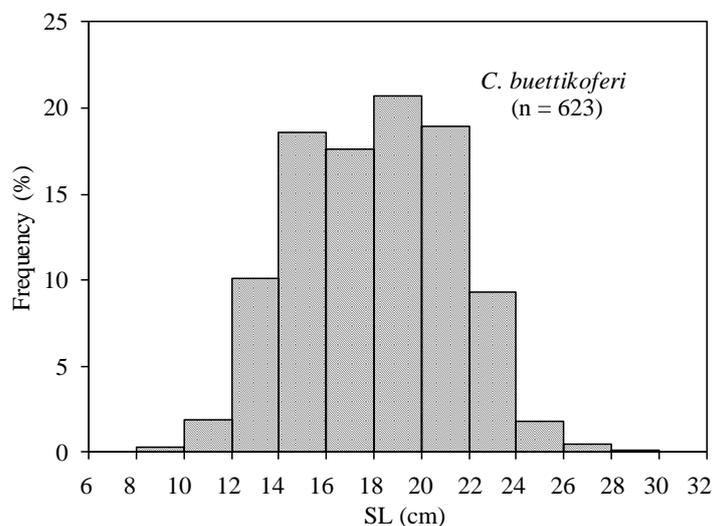
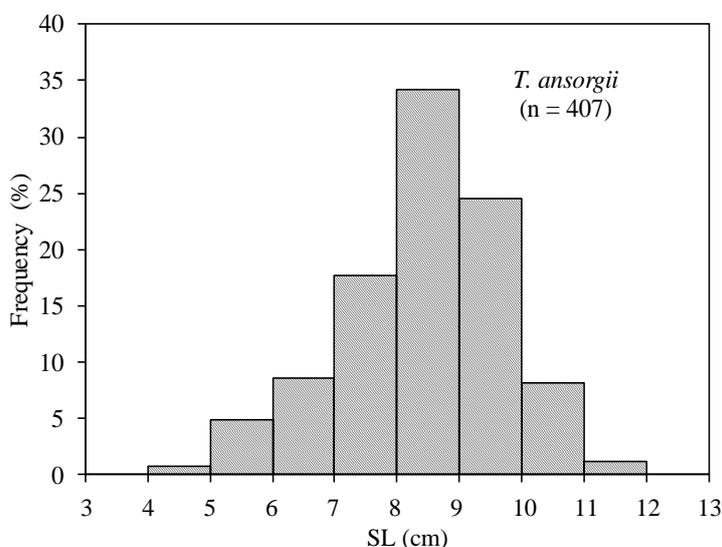
frequency distribution showed that the population of *C. buettikoferi* was not normally distributed (Shapiro-Wilk normality test ; $P < .05$). The Length of specimens ranging from 14 to 22 cm represented 76.0% of the population. Males (29.30 cm) reached a larger size than females (25.00 cm). So, the comparison of the SF frequency distributions showed significant differences (Two-Tailed, Mann-Whitney U = 38 659 ; $P < .05$) between male (median = 18.35 cm) and female (median = 17.30 cm). Furthermore, the SL of *T. ansorgii* varied from 4.60 cm to 11.50 cm (mean±SD = 8.32±1.28) and the BW ranged from 2.45 g to 65.62 g (mean±SD = 27.28±12.26). The SL frequency distribution of *T. ansorgii* was not normally distributed (Shapiro-Wilk normality test ; $P < .05$). The SL varying between 7 and 10 cm were the most abundant (76.50%). In the same, the SL of male was significantly higher (MW, U = 15 924 ; $P < .05$) for male (median = 8.70 cm) than that for female (median = 8.30 cm). For the specimens of *P. obscura*, the SL varied from 10.70 cm and 29.30 cm (mean±SD = 19.51±3.93). The most abundant individuals had a SL varying between 16 cm and 24 cm (74%). The comparison of size frequency distribution don't show significant differences (MW=248,5 ; $P < .05$) between male (median = 19.0 cm) and female (median =19.7 cm).

Table 1. Descriptive statistics on the length (cm) and weight (g) measurements of three fish species from the Tanoe-Ehy swamp forest, Côte d'Ivoire

Species	Measurements	n	min-max	Mean±SD	CL 95%
<i>Clarias buettikoferi</i>	Male	378			
	SL		9.50-29.30	18.26±3.41	17.91-18.60
	TL		10.60-31.80	20.52±3.69	20.15-20.89
	BW		8.50-205.00	77.24±38.53	73.34-81.13
	Female	246			
	SL		10.80-25.00	17.36±2.89	17.00-17.73
	TL		12.30-28.20	19.55±3.17	19.15-19.94
	BW		16.80-186.00	65.85±32.65	61.75-69.95
	Combined sex	623			
SL	9.50-29.30		17.90±3.24	17.65-18.16	
TL	10.60-31.80		20.13±3.53	19.85-20.41	
BW		8.50-205.00	72.71±36.74	69.82-75.60	
<i>Thysochromis ansorgii</i>	Male	199			
	SL		5.50-11.50	8.58±1.37	8.39-8.77
	TL		7.50-15.00	11.47±1.85	11.21-11.73
	BW		6.20-65.62	30.14±14.25	28.14-32.13
	Female	208			
	SL		4.60-10.40	8.08±1.13	7.92-8.23
TL	5.80-14.00		10.66±1.47	10.45-10.86	
BW		2.40-46.62	24.54±9.23	23.28-25.80	

Species	Measurements	n	min-max	Mean±SD	CL 95%
	Combined sex	407			
	SL		4.60-11.50	8.32±1.28	8.20-8.44
	TL		5.80-15.00	11.05±1.71	10.89-11.22
	BW		2.40-65.62	27.28±12.26	26.08-28.47
<i>Parachanna obscura</i>	Male	27			
	SL		10.70-29.30	19.16±4.52	17.37-20.94
	TL		12.70-35.6	22.78±5.25	20.70-24.86
	BW		15.50-390.00	116.02±90.50	80.22-151.82
	Female	23			
	SL		13.30-26.90	19.92±3.14	18.56-21.27
	TL		16.00-29.50	23.50±3.48	21.99-25.00
	Combined sex	50			
	SL		10.70-29.30	19.51±3.93	18.39-20.62
	TL		12.70-35.60	23.11±4.5	21.83-24.39
	BW		15.50-390.00	116.19±76.53	94.44-137.94

n, sample size; *Min*, minimum; *Max*, maximum; *SD*, standard deviation; *CL*, confidence limit for mean values; *SL*, standard length; *TL*, total length; *BW*, body weight



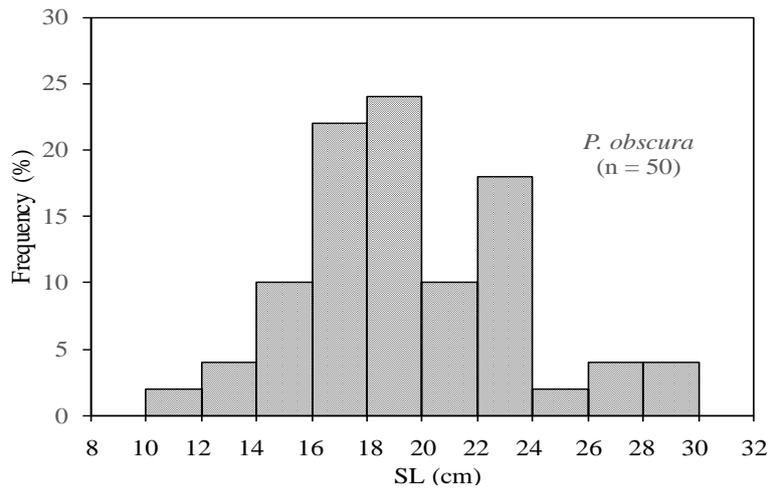


Fig. 2. Length-frequency distribution of the three species from the Tanoe-Ehy swamp forest, Côte d'Ivoire

3.2 Length-Weight Relationships

The sample size (n), a and b for the LWR, coefficients of determination (r^2) and growth type of *C. Buettikoferi*, *T. ansorgii* and *P. obscura* are given in Table 2. The intercept " a " varied between 0.0138 and 0.0290, b between 2.5139 and 3.2796, and r^2 between 0.841 and 0.949. For the population (sex and season combined) of *C. buettikoferi*, growth was negative allometric ($b < 3$) and had not varied between seasons. This growth type was the same in males. On the other hand, for females of *C. buettikoferi*, the growth type was isometric in dry season and negative allometric in flooded season and b showed significant differences (MW, $U = 230$; $P < .05$). For the population (sex and season combined) of *T. ansorgii*, the growth type was isometric ($b = 3$) and varied between seasons; it was allometric positive in dry season and isometric in flooded season, and b showed significant differences between seasons (MW = 436; $P < .05$). For males of *T. ansorgii*, the growth type had not change between seasons. However, it was positive allometric in dry season and isometric in flooded season for females with significantly different values of b between seasons (MW, $U = 4$; $P < .05$). The growth type was negative allometric and has varied between seasons for *P. obscura*. It was isometric in dry season and negative allometric in flooded season with significantly different values of b (MW, $U = 33$; $P < .05$).

3.3 Condition Factors

The Fulton's condition factor ranged from 1.16 ± 0.16 to 1.24 ± 0.41 according to sex and

seasons in *C. buettikoferi* (Table 2). K_F varied significantly (MW ; $U = 13\ 540$; $P < .05$) between dry season (median=1.18) and flooded season (median=1.14). K_F varied between 1.37 ± 0.26 and 1.44 ± 0.37 , then between 4.37 ± 0.52 and 4.47 ± 0.55 , for *P. obscura* and *T. ansorgii*, respectively. No significant differences (MW, $P < .05$) in K_F was observed in males and females of both species according to season.

The relative condition factor K_R varied between 0.76 ± 0.12 and 2.02 ± 0.41 for the three species. K_F was higher in flooded season and varied significantly (MW, $P < .05$) between dry and flooded seasons in male and female of three species.

The Spearman rank test revealed that SL was strongly correlated with BW for all species ($P < .01$) (Table 3). In the same, K_R was correlated with K_F and BW for all species ($P < .01$). For *C. buettikoferi*, K_F was negatively correlated with SL only in rainy season in males ($r_s = -0.205$; $P < .01$) and specimens of combined sex ($r_s = -0.187$; $P < .01$). K_F is positively correlated with BW in dry season in males ($r_s = 0.245$; $p < .01$), females ($r_s = 0.369$; $P < .01$) and specimens of combined sex ($r_s = 0.302$; $P < .01$). For *T. ansorgii*, K_F was positively correlated with SL in dry season while K_F was correlated with BW in all seasons. There is no significant correlation between K_R and SL, BW. K_R was positively correlated with SL ($r_s = 0.407$; $P < .01$) in *P. obscura*.

Table 2. Parameters of the length-weight relationships (LWR) and Condition factor of the three fish species from the Tanoe-Ehy swamp forest, Cote d'Ivoire

Species	Sex	Seasons	n	Parameters of LWR					KF	KR
				a	b	r ²	ts	GT	mean±SD	mean±SD
<i>C. buettikoferi</i>	M	AS	378	0.0215	2.6828	0.861	-5.72	A-	1.20±0.49	1.39±0.48
		DS	133	0.0209	2.7243	0.883	-3.18	A-	1.24±0.41	1.50±0.42
		FS	245	0.0239	2.5891	0.841	-5.69	A-	1.17±0.53	1.59±0.57
	F	AS	246	0.0153	2.9503	0.925	-0.93	I	1.16±0.17	0.88±0.13
		DS	114	0.0138	3.0379	0.898	0.39	I	1.17±0.19	0.76±0.12
		FS	132	0.0167	2.8787	0.935	-1.82	A-	1.16±0.16	0.98±0.13
	CS	AS	623	0.0191	2.7746	0.884	-5.58	A-	1.19±0.40	1.18±0.36
		DS	246	0.0179	2.8362	0.887	-2.53	A-	1.21±0.33	1.09±0.27
		FS	377	0.0211	2.6857	0.874	-5.98	A-	1.17±0.44	1.35±0.43
<i>T. ansorgii</i>	M	AS	199	0.0239	3.0775	0.940	1.40	I	4.42±0.59	1.57±0.21
		DS	99	0.0230	3.1186	0.945	1.55	I	4.43±0.53	1.49±0.17
		FS	100	0.0246	3.0467	0.928	0.54	I	4.41±0.65	1.63±0.24
	F	AS	208	0.0246	3.0480	0.937	0.87	I	4.41±0.54	1.62±0.20
		DS	121	0.0198	3.2796	0.930	3.40	A+	4.37±0.52	1.23±0.14
		FS	87	0.0281	2.9050	0.949	-1.30	I	4.47±0.55	1.93±0.23
	CS	AS	407	0.0243	3.0618	0.884	1.53	I	4.42±0.56	1.81±0.23
		DS	220	0.0213	3.1949	0.942	3.61	A+	4.39±0.53	1.36±0.16
		FS	187	0.0264	2.9720	0.938	-0.50	I	4.44±0.61	1.78±0.24
<i>P. obscura</i>	CS	AS	50	0.0242	2.6536	0.879	-2.44	A-	1.41±0.30	1.62±0.32
		DS	24	0.0218	2.7347	0.880	-1.23	I	1.38±0.21	1.42±0.25
		FS	26	0.0290	2.5139	0.852	-2.28	A-	1.44±0.37	2.02±0.41

M, male ; F, female ; CS, Combined Sex ; n, sample size ; AS, all season ; DS, Dry season ; FS, flooded season ; a, intercept ; b, slope ; r², coefficient of determination ; ts, t-test value ; GT, Growth type ; A-, Negative allometric ; A+, Positive allometric ; I, Isometric. ; K_F, Fulton's Condition factor ; K_R, Relative Condition factor

Table 3. Spearman rank correlation for Standard Length (SL), body weight (BW), Fulton's condition factor (K_F) and Relative condition factor (K_R) of three fish species from the Tanoe-Ehy swamp forest, Côte d'Ivoire

Species	Sex	Seasons	SL-BW	SL-K _F	SL-K _R	BW-K _F	BW-K _R	K _F -K _R
<i>C. buettikoferi</i>	M	AS	0.947*	-0.103	0.263*	0.168*	0.520*	0.906*
		DS	0.915*	-0.102	0.202	0.245*	0.526*	0.927*
		FS	0.942*	-0.205*	0.270*	0.054	0.514*	0.851*
	F	AS	0.962*	-0.028	0.037	0.209*	0.272*	0.997*
		DS	0.929*	0.071	0.034	0.369*	0.334*	0.998*
		FS	0.968*	-0.150	0.010	0.064	0.223*	0.981*
	CS	AS	0.953*	-0.074	0.199*	0.182*	0.447*	0.949*
		DS	0.937*	-0.001	0.169*	0.302*	0.463*	0.979*
		FS	0.951*	-0.187*	0.199*	0.055	0.432*	0.902*
<i>T. ansorgii</i>	M	AS	0.959*	0.092	-0.012	0.324*	0.222*	0.992*
		DS	0.960*	0.184	0.036	0.414*	0.272*	0.984*
		FS	0.954*	0.014	-0.044	0.261*	0.204	0.997*
	F	AS	0.936*	0.080	0.027	0.367*	0.316*	0.998*
		DS	0.931*	0.256*	-0.001	0.553*	0.313*	0.941*
		FS	0.939*	-0.105	0.010	0.173	0.289*	0.989*
	CS	AS	0.953*	0.076	0.076	0.324*	0.324*	0.999*
		DS	0.954*	0.209*	-0.007	0.457*	0.251*	0.965*
		FS	0.949*	-0.058	-0.021	0.204*	0.241*	0.998*
<i>P. obscura</i>	CS	AS	0.972*	0.049	0.407*	0.229	0.564*	0.891*
		DS	0.974*	0.262	0.497	0.419	0.637*	0.929*
		FS	0.955*	-0.252	0.291	-0.051	0.479	0.773*

4. DISCUSSION

The present study reported for the first time the length-weight parameters of three fish species in Tanoe-Ehy swamp forest. A total of 623, 407 and 50 specimens of *C. buettikoferi*, *T. ansorgii* and *P. obscura* were captured using gillnets and fyke nets, respectively. The maximum length of *C. buettikoferi* found in this study was 29.30 cm SL (31.80 cm TL), which is greater than the maximum value of 15 cm SL in Aby Lagoon [28] and 19.2 cm TL reported by [29]. For *T. ansorgii*, the maximum length of 15.0 cm TL (11.50 cm SL) is also greater than 12.5 cm TL obtained by [30] in Nigerian freshwater. However, the maximum length of *P. obscura* is less than the length of 30.8 cm SL [31] and 34 cm SL reported in the coastal rivers in South-eastern of Côte d'Ivoire [32].

These results tend to show an environment favorable to development of *C. buettikoferi* and *T. ansorgii*, which may justify the great abundance of both species in the TEF [3]. In addition, several areas are inaccessible to fishing activities, and this can allow fish populations to develop well, unlike other adjacent ecosystems where fishing was done all year round. Indeed, according to several works, fishing activities have a considerable impact on the reduction of the size of fish population [33,34]. The length at first sexual maturity (Lm) of fish is widely used as an indicator for minimum permissible capture size and is of special interest in fisheries management [35,36]. The length of first maturity of *C. buettikoferi* (♀ = 13 cm SL ; ♂ = 14.8 cm SL) and *T. ansorgii* (♀ = 6.9 cm LS ; ♂ = 8.1 cm LS) showed that most samples were from adult individuals, which indicates a low impact of fishing on fish size in the TEF. Although information on the length at first sexual maturity (Lm) of *P. obscura* is lacking in TEF, data from the literature (♀ = 25.8 cm LT ; ♂ = 26.6 cm LT) also indicated a heterogeneous population [37].

The length frequency of *C. buettikoferi* and *T. ansorgii* showed significant differences between male and female. It may be related to a sexually dimorphic growth pattern in which males grow faster and bigger than females [38]. The Length-weight relationship (LWR) parameters indicated negative allometric growth for combined sex individuals in *C. buettikoferi* and *P. obscura* and isometric growth type in *T. ansorgii*. The values of *b* varied between 2.5139 and 3.2796 and are the range of values (2-4) usually encountered in fishes [16]. These growth type exhibited seasonal

variations. In fact, for *C. buettikoferi* females and *P. obscura*, it was isometric in dry periods and negative allometric (that means fish grow faster in length than in weight) in rainy periods. In contrast, for *T. ansorgii*, the growth type was positive allometric (fish grow faster in weight than in length) in dry periods and isometric in rainy periods.

These results suggest that fish species increase in length than in weight during rainy periods. According to several authors, Length-weight parameters are influenced by many factors such as the season and effects of different areas, gonad maturity, food availability, stomach fullness, and environmental conditions [16,39,40]. In the present study, the most likely hypothesis of this seasonal variation in growth would be related to the food resources availability and environmental quality. Indeed, previous studies carried out in the FMTE [8,9,41] showed a greater variety of prey during the rainy seasons and environmental conditions more favorable to survival of larvae and juvenile fish. On the contrary, the water depth considerably decreases during dry periods and the aquatic environment becomes acidic and hypoxic, impacting prey abundance [3]. These changes in growth pattern linked to modification of hydrological regime has also been reported in several freshwater species from Lake Buyo such as *Mormyrus rume*, *Chrysichthys nigrodigitatus* and *Schilbe mandibularis* [12]. Effects of seasons and food availability on the LWR has been reported in *Liza ramada*, *Oblada melanura* and *Epinephelus costae* from the marine area of Tripoli [41]. The negative allometric growth in *C. buettikoferi* corroborates the results of [28] in Aby lagoon. The high coefficient of determination values obtained in the assessment of LWRs means a good quality of the prediction of a linear regression for the analyzed fish species, and suggest that extrapolation in future catches can be done in the TEF for this size range [42].

Condition factors are used to check the overweight condition of the species [27]. They have generally been used to assist in assessing the state of health and productivity of fish [16]. In the present study, KF and KR ranged from 1.16 to 4.47, then 0.88 to 2.02, respectively and a significant correlation was observed between both parameters. Indeed, K_R was the best predictor because it was derived from the LWR and takes into account the parameters "a" and "b" of each species [27]. K_R showed significantly higher values in rainy seasons compared to dry

seasons, showing the influence of seasons on the fish overweight. He reported an overall fitness for fish species is assumed when K_R values are equal or close to 1 [43,44]. This parameter is used to assess suitability of a specific water environment for growth of fish, which shows a good condition of habitat in the TEF to support the fish growth, especially in flooded seasons. In fact, rainy periods offer a large abundance of available preys and favorable environmental conditions [8,9], which justifies the well-being of fish during these periods. The low K_R values in females unlike males of *C. buettikoferi* tend to show that the use of energy resources by females for reproductive success [3] has an impact on their condition.

5. CONCLUSION

The present study reported the length-weight parameters of three constant species for the first time in the Tanoé-Ehy swamp forest and the influence of sexes and seasons on these parameters. The condition factors seemed to indicate that swampy forest might be a favorable aquatic environment for the survival and development of these species, especially in flooded seasons. These results would be an effective tool for fishery biologists, managers and conservationists to initiate prompt management strategies and regulations for the sustainable conservation of stocks of these species.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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